

*Citation for published version:*

Formisano, N, Jolly, P, Cromhout, M, Flanagan, S, Fogel, R, Limson, J & Estrela, P 2014, 'Correlating electrochemical impedance spectroscopy and quartz crystal microbalance with dissipation signals for optimisation of aptamer-based biosensors', 24th Anniversary World Congress on Biosensors, Melbourne, Australia, 27/05/14 - 30/05/14.

*Publication date:*  
2014

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication](#)

**University of Bath**

## **Alternative formats**

If you require this document in an alternative format, please contact:  
[openaccess@bath.ac.uk](mailto:openaccess@bath.ac.uk)

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.





UNIVERSITY OF  
**BATH**

# Optimisation of an Electrochemical Impedance Spectroscopy aptasensor by exploiting Quartz Crystal Microbalance with Dissipation signals

Nello Formisano<sup>1\*</sup>, Pawan Jolly<sup>1</sup>, Mary Cromhout<sup>2</sup>, Shane Flanagan<sup>2</sup>, Ronen Fogel<sup>2</sup>, Janice L. Limson<sup>2</sup>, Pedro Estrela<sup>1</sup>

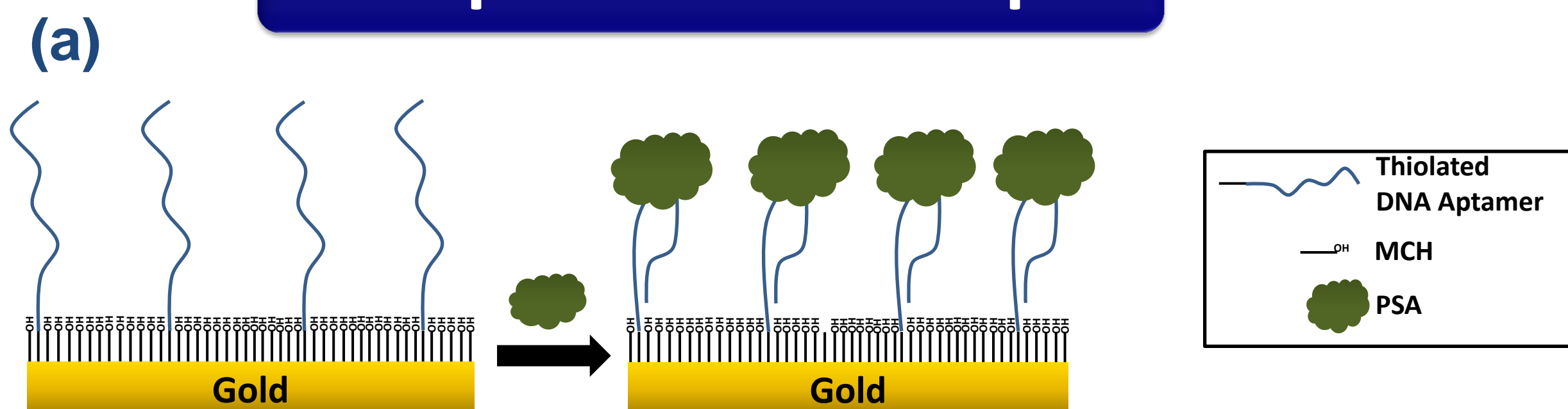
<sup>1</sup>University of Bath, UK; <sup>2</sup>Rhodes University, South Africa

\*n.formisano@bath.ac.uk

## Introduction

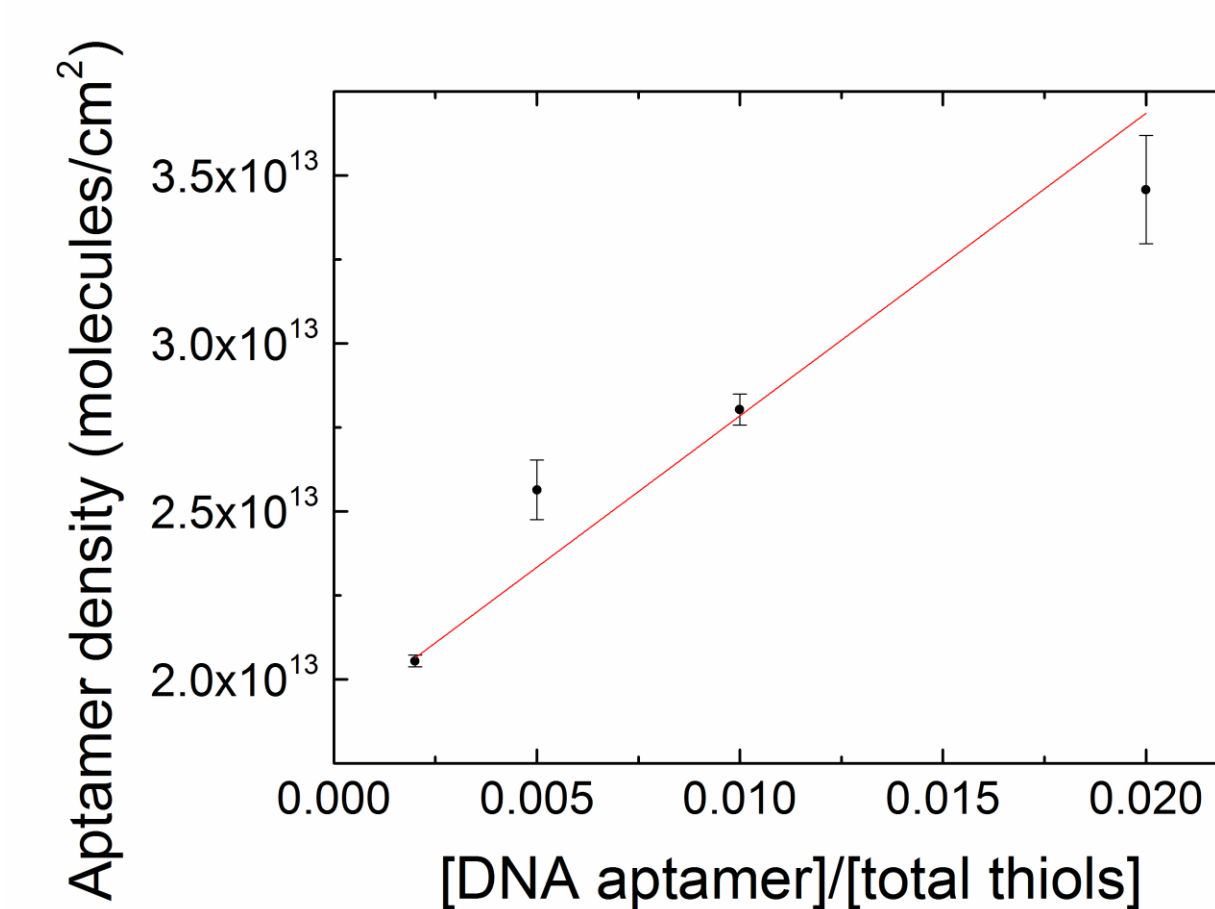
- Electrochemical Impedance Spectroscopy (EIS) is a fast, sensitive and relatively inexpensive label-free tool, which can be employed for a wide range of applications including for cancer diagnostics.
- EIS-based biosensors using DNA/RNA aptamers require a careful design in order to be most efficient. In this study we investigated the performance of an impedimetric aptasensor by comparing EIS to Quartz Crystal Microbalance with Dissipation (QCM-D) signals.

## Experimental setup



- This study focused on Prostate Specific Antigen (PSA) detection by using a target-specific DNA aptamer.
- The self assembled monolayer comprises a mixture of 6-mercaptohexanol (MCH) and thiolated-DNA aptamer.

## Experimental setup

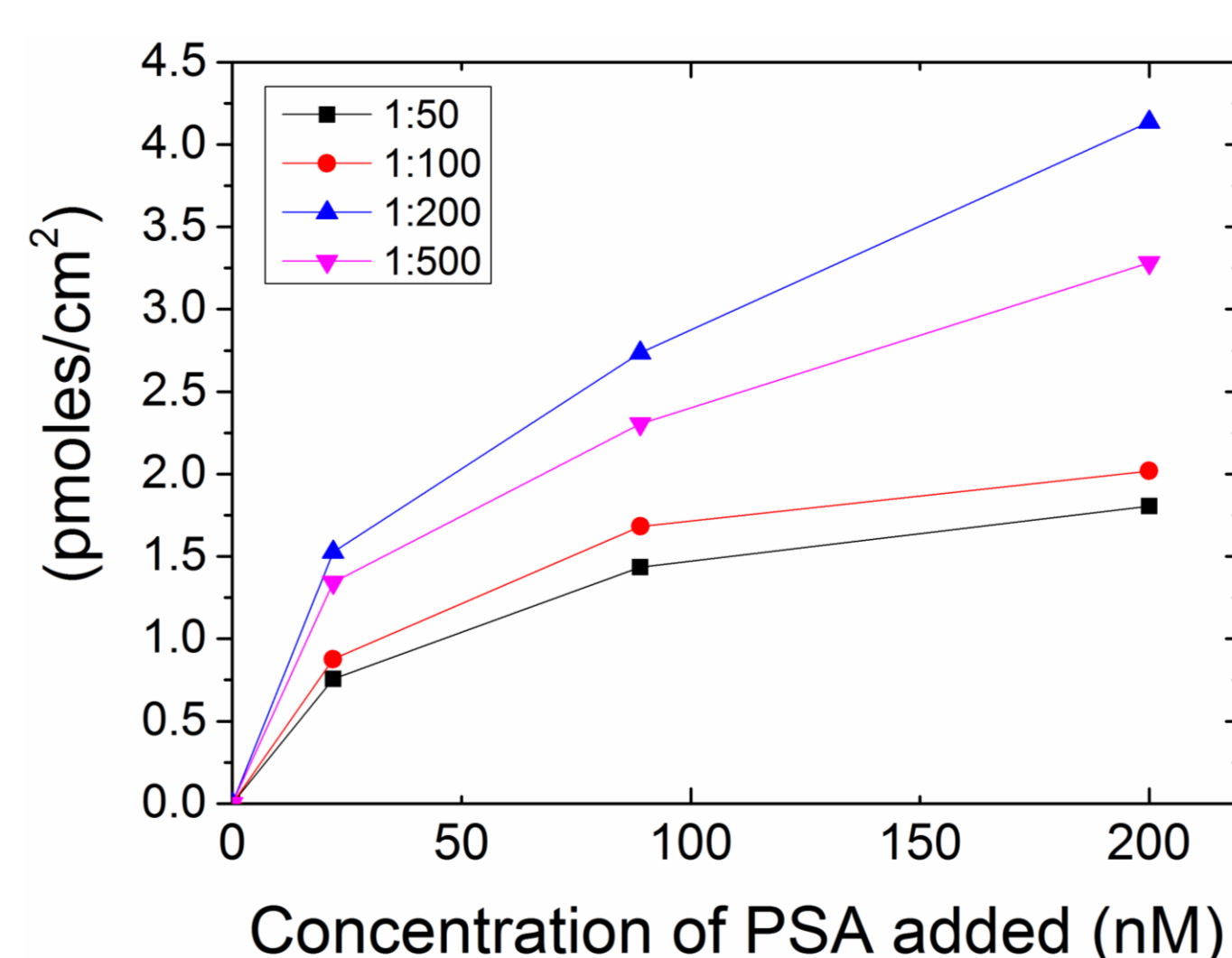


- The biosensor behaviour was analysed varying three different buffers for the assay and four ratios of MCH/Aptamer for the sensor modification.
- QCM-D and EIS measurements were then recorded.

## Results

QCM-D measurements performed in:

- EIS buffer (50 mM PB, 100 mM K<sub>2</sub>SO<sub>4</sub>, pH 7.0), HMCKN buffer (20 mM HEPES, 2 mM MgCl<sub>2</sub>, 2 mM CaCl<sub>2</sub>, 2 mM KCl and 150 mM NaCl, pH 7.4), TBS buffer (10 mM Tris HCl, 150 mM NaCl, 5 mM KCl, 5 mM MgCl<sub>2</sub>, pH 7.4).
- Only TBS buffer (with which the aptamer was raised) showed binding.

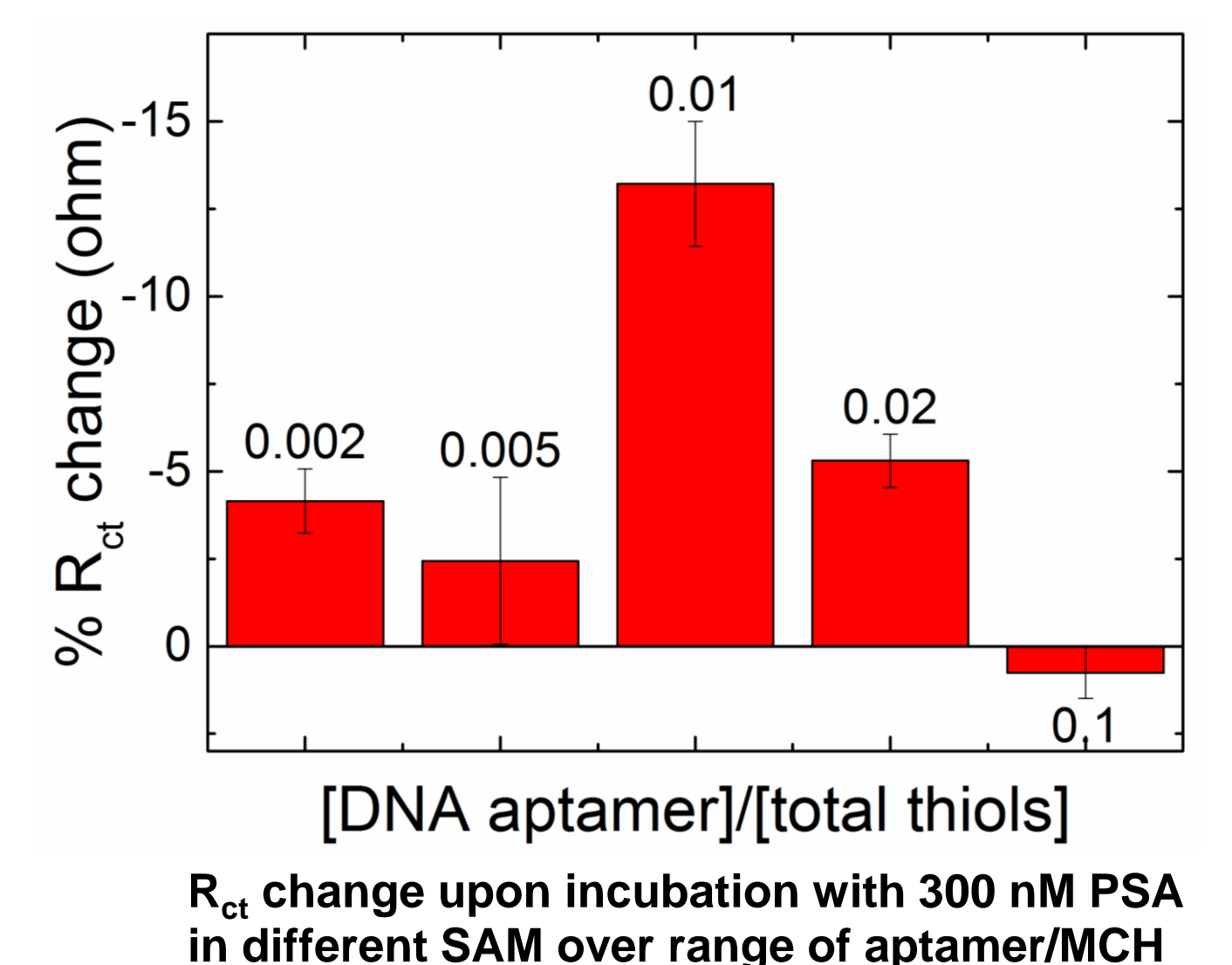


- Using TBS buffer, three aptamer/MCH ratios have been tested for the surface coverage: 1:50, 1:100, 1:200, 1:500.

## Results

EIS measurements:

- The impedance of the biosensor is due to a combination of the obstruction effect towards [Fe(CN)<sub>6</sub>]<sup>3-/4-</sup> redox couple and screening of the DNA aptamer charge.
- Negative shifts in  $R_{ct}$  were recorded as a result of the prevalence of screening of the DNA aptamer charge.
- Although 1:200 was the ratio that ensures maximum extent of PSA binding (from QCM-D results), this did not correspond to the ratio that maximize the shift in  $R_{ct}$  concentration fraction.



## Conclusions

- Regardless of the great potential of aptamers versus antibodies in biosensing, aptasensors need a careful design in order to provide an acceptable binding efficiency. The conditions which allow a maximum analyte binding do not necessarily also provide the best settings in terms of impedance recordings.
- QCM-D results confirmed the importance of buffer conditions and surface optimization for efficient aptamer-protein binding. In particular a ratio 1:200 of aptamer:MCH provides the maximum PSA binding.
- However, EIS data demonstrated a different optimal surface coverage ratio as compared to QCM-D because of additional factors governing the EIS measurements. The results of this study can be applied to future label-free, reliable and cost effective aptamer-based sensors exploiting EIS.

